PATENT ABSTRACTS OF JAPAN

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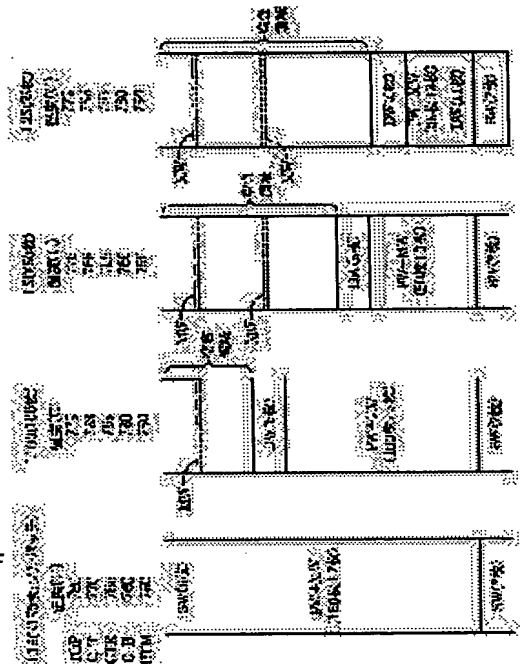
(54) FILM FORMING METHOD AND FILM FORMING APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To solve the problem that, in a film forming process in a short batch with an empty region, without fully mounting semiconductor wafers on a wafer boat e.g. in a longitudinal heat treating apparatus for heat treating the wafers in a batch system, a process gas is not consumed for the wafer in the empty region but deposits its unconsumed amount to the inner wall of a reaction chamber and the wafer boat resulting in a large total thickness of deposited films and this value cannot be found resulting in a shortened maintenance period.
SOLUTION: The film forming method comprises previously mounting dummy wafers on a wafer boat, the same as laying wafers in a short batch for product wafers, placing a monitor wafer on an empty region, executing the same process to measure the thickness of a thin film on the monitor wafer W1 as in the practice, comparing the measured film thickness with that on a wafer W2 in a region for placing the product wafer and adjusting the heating rate of a heater corresponding to the empty region so that the film thickness on the monitor wafer W1 is equal to that on the wafer W2.



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CLAIMS

[Claim(s)]
[Claim 1] The full batch mode which supplies raw gas in a reaction container and performs membrane formation processing to a substrate while carrying a full load of a substrate in the holder which carries out array maintenance of many substrates in the die-length direction of a reaction container, carrying in in a reaction container and heating the inside of a reaction container, In the approach of performing membrane formation processing using the membrane formation processor equipped with the short batch mode which performs membrane formation processing where it made the substrate holding to a part of installation field of the substrate in said holder and the remaining installation fields are made into a free area The process which lays a monitor substrate in a free area and performs a short batch mode, It is characterized by including the process which predicts the built up film thickness of the equipment component in the location corresponding to a free area based on the measurement result of the thickness in the process which measures the thickness of said monitor substrate, and this process after this process.
[Claim 2] The full batch mode which supplies raw gas in a reaction container and performs membrane formation processing to a substrate while carrying a full load of a substrate in the holder which arranges many substrates in the die-length direction of a reaction container, carrying in in a reaction container and heating the inside of a reaction container, In the approach of performing membrane formation processing using the membrane formation processor equipped with the short batch mode which performs membrane formation processing where it made the substrate holding to a part of installation field of the substrate in said holder and the remaining installation fields are made into a free area The process which lays a monitor substrate in a free area and performs a short batch mode, It is based on the measurement result of the thickness in the process which measures the thickness of said monitor substrate, and this process after this process. The membrane formation approach characterized by including the process which adjusts the temperature of the ambient atmosphere corresponding to a free area so that the membrane formation rate of said monitor substrate may become [whether it is almost the same as the membrane formation rate in the field to which the substrate is arranged, and] rather than it.
[Claim 3] The full batch mode which supplies raw gas in a reaction container and performs membrane formation processing to a substrate while carrying a full load of a substrate in the holder which carries out array maintenance of many substrates in the die-length direction of a reaction container, carrying in in a reaction container and heating the inside of a reaction container, In the approach of performing membrane formation processing using the membrane formation processor equipped with the short batch mode which performs membrane formation processing where it made the substrate holding to a part of installation field of the substrate in said holder and the remaining installation fields are made into a free area The membrane formation approach characterized by setting up the ambient temperature in which a free area is located lower than the ambient temperature of the location concerned at the time of a full batch mode when performing a short batch mode.
[Claim 4] It is the membrane formation approach according to claim 1, 2, or 3 which is divided

into plurality so that the temperature control of the heating means can be carried out respectively independently corresponding to said two or more zones, and is characterized by performing adjustment of said ambient temperature by adjusting the calorific value of each heating means while the heat treatment ambient atmosphere in a reaction container is divided into two or more zones.

[Claim 5] The full batch mode which supplies raw gas in a reaction container and performs membrane formation processing to a substrate while carrying a full load of a substrate in the holder which carries out array maintenance of many substrates in the die-length direction of a reaction container, carrying in in a reaction container and heating the inside of a reaction container with a heating means, In the membrane formation processor equipped with the short batch mode which performs membrane formation processing where it made the substrate hold to a part of installation field of the substrate in said holder and the remaining installation fields are made into a free area Membrane formation equipment characterized by the laying temperature of the ambient atmosphere in which the free area at the time of a short batch mode is located being lower than the laying temperature of the ambient atmosphere of the location concerned at the time of a full batch mode.

[Claim 6] Membrane formation equipment according to claim 5 characterized by the membrane formation rate in a free area being almost the same as the membrane formation rate in the field to which the substrate is arranged, or being smaller than it.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the membrane formation approach and membrane formation equipment.
[0002]
[Description of the Prior Art] many — for example, the vertical mold thermal treatment equipment is known as equipment which bundles up to several semi-conductor wafers (henceforth a wafer), and performs membrane formation processing. the wafer boat 91 which is a wafer holder as this equipment is shown in drawing 6 — many — several wafers W are held to ledged, it carries in from a lower part side in the reaction container 92 of a vertical mold, and lower limit opening is plugged up, heating Wafer W to predetermined process temperature at the heater 93 formed in the perimeter of the reaction container 92, raw gas is supplied and membrane formation processing by CVD is performed to Wafer W. By the way, if it is in recently, since a variety of semiconductor devices are required, heat treatment may be needed to the wafer W of many forms with a small lot. For this reason, when [which is full number of sheets, for example as a product wafer] performing processing of 150 sheets, for example, supposing a wafer boat 91 is in the full batch condition which turns into a loaded condition, the short batch mode which heat-treats by carrying number of sheets smaller than it, for example, 100 sheets, 50 sheets, or 25 product wafers in a wafer boat 91 may be given into a recipe. The loading condition of the wafer W shown in drawing 6 corresponds to a short batch mode, makes Wafer W bottom stuffing, and makes the upper part side the free area.
[0003] When performing such a short batch mode, it is not a best policy from a cost side that only insufficient number of sheets carries a full load of a wafer boat 91 using a dummy wafer. The reason has an expensive dummy wafer and is because it is finally discarded by repeat use, so a running cost soars. Then, it is examining performing homogeneous high heat treatment by performing the various devices of using the dummy wafer of the pressure regulation corresponding to the method of installation of a product wafer, and a short batch a few, forming a free area without making a wafer boat 91 into a loaded condition.
[0004]
[Problem(s) to be Solved by the Invention] By the way, he is trying to decide the timing which predicts the built up film thickness of the wall of a wafer boat 91 and the reaction container 92 based on [since a possibility that film peeling will take place if a thin film adheres to the wall of the wafer boat 91 which is the equipment component exposed to a heat treatment ambient atmosphere, and the reaction container 92 and thickness becomes large, and particle may occur becomes large] the target thickness of a product wafer, and washes a wafer boat 91 and the reaction container 92 based on the prediction result. However, when carrying out membrane formation processing of the wafer in short batch, in order that there may be no wafer which consumes membrane formation gas in a free area, the membrane formation rate in the part located in the free area in a wafer boat 91 and the reaction container 92 becomes larger than the membrane formation rate of the part located in the field in which the wafer is laid. For this reason, as shown in drawing 6 in [container / 92 / reaction] image, the built up film thickness

of the former thin film 90 will become larger than the built up film thickness of the latter thin film 90. It is necessary to wash the reaction container 92 before the timing of washing for which it opted beforehand as a result, and the technical problem that a maintenance cycle becomes short occurs. Moreover, since the built up film thickness of a part located in the free area in a wafer boat 91 and the reaction container 92 cannot be grasped, it is difficult to predict a maintenance cycle.

[0005] It is in offering the technique in which the purpose can predict the built up film thickness which adheres to the part located in the free area in an equipment component in performing membrane formation processing of a substrate by the short batch mode in which a free area exists, without carrying a full load in a holder of a substrate by this invention being made by the basis of such a situation, and a maintenance cycle can prevent from becoming short.

[0006]

[Means for Solving the Problem] The full batch mode which supplies raw gas in a reaction container and performs membrane formation processing to a substrate while invention of claim 1 carries a full load of a substrate in the holder which carries out array maintenance of many substrates in the die-length direction of a reaction container, carries it in in a reaction container and heating the inside of a reaction container, In the approach of performing membrane formation processing using the membrane formation processor equipped with the short batch mode which performs membrane formation processing where it made the substrate holding to a part of installation field of the substrate in said holder and the remaining installation fields are made into a free area The process which lays a monitor substrate in said free area, and performs a short batch mode, It is characterized by including the process which predicts the built up film thickness of the equipment component in the location corresponding to a free area based on the measurement result of the thickness in the process which measures the thickness of said monitor substrate, and this process after this process.

[0007] "The process which lays a monitor substrate in a free area and performs a short batch mode" in this invention may be performed in the process which may carry out to the adjustment process before actually performing membrane formation processing to a product wafer, or performs membrane formation processing to a product wafer. Since according to this invention the built up film thickness of the film adhering to the equipment component (a gestalt the reaction container and wafer boat 4 of operation) in the location corresponding to a free area can be predicted, therefore it can maintain to suitable timing, the particle contamination by film peeling from an equipment component can be prevented.

[0008] The process which invention of claim 2 lays a monitor substrate in a free area, and performs a short batch mode, It is based on the measurement result of the thickness in the process which measures the thickness of said monitor substrate, and this process after this process. It is characterized by including the process which adjusts the temperature of the ambient atmosphere corresponding to a free area so that the membrane formation rate of said monitor substrate may become [whether it is almost the same as the membrane formation rate in the field to which the substrate is arranged, and] rather than it.

[0009] Invention of claim 3 is characterized by setting up the ambient temperature in which a free area is located lower than the ambient temperature of the location concerned at the time of a full batch mode, when performing a short batch mode.

[0010] Only the part in which a substrate does not exist compared with the case where it carries a full load of a substrate in a free area can suppress that a maintenance cycle (washing cycle) becomes short by adjusting laying temperature like these invention, although many film adheres to an equipment component.

[0011] Moreover, this invention is realized also as membrane formation equipment, and the equipment is characterized by the laying temperature of the ambient atmosphere in which the free area at the time of a short batch mode is located being lower than the laying temperature of the ambient atmosphere of the location concerned at the time of a full batch mode.

[0012]

[Embodiment of the Invention] The example which enforces the membrane formation approach of this invention with a vertical mold thermal treatment equipment is given to below, and the gestalt

of implementation of invention is explained to it. This equipment is equipped with the coil 1 of the double pipe structure of the product made from a quartz for example, which consists of outer-tube 1b which inner-tube 1a and the upper limit both ends are carrying out [upper limit] opening blockade if the configuration of a vertical mold thermal treatment equipment is explained referring to drawing 1 and drawing 2 first. If the heat treatment ambient atmosphere in this coil 1 is seen from a control system, it is divided into five steps of zones. And around the coil 1, the heater 2 which is the heating means which consists of a resistance heating element is divided into percent, for example, five steps, up and down for two or more minutes, for example, and heater 2a of each stage, 2b, and 2c, 2d and 2e are constituted, respectively so that heating control of five steps of said zones may be taken charge of.

[0013] Inner-tube 1a and outer-tube 1b are supported on the tubed manifold 3 in a lower part side. To this manifold 3 They are two or more gas supply lines 31 (two gas supply lines 31a and 31b are shown for convenience by a diagram.) so that a feed hopper may carry out opening to the lower field inside inner-tube 1a. While being prepared, the exhaust pipe 32 by which the end side was connected to the vacuum pump which is not illustrated so that it may exhaust from between inner-tube 1a and outer-tube 1b is connected. A reaction container is constituted from this example by inner-tube 1a, outer-tube 1b, and the manifold 3.

[0014] Furthermore, the lid 11 is formed so that lower limit opening of a manifold 3 may be plugged up, and this lid 11 is formed on the boat elevator 12. On a lid 11, the rotation base 14 is formed through the revolving shaft 13 which rotates by the mechanical component which is not illustrated, and the wafer boat 4 which is a substrate holder is carried through the heat insulation unit 15 which consists of a heat insulating mould on this rotation base 14. Two or more stanchions 43 are formed between a top plate 41 and a bottom plate 42, and a wafer boat 4 is constituted, as shown in drawing 2 , and it is constituted so that the wafer W which are many substrates can be laid in ledged by holding the periphery of each wafer W to the retention groove 44 formed in said stanchion 43. **** to which the product wafer W is made as for a wafer boat 4 — from the monitor-wafers which act as the monitor of the condition of processing being also scattered, and being placed, while the wafer called a side wafer to an upper limit and lower limit side is laid at the time of a full batch, in order to put on a uniform heating ambient atmosphere If it is in some which a number of slots which expected these wafers in addition to the product wafer are installed, for example, carry 150 product wafers W, the retention groove 44 for 170 sheets is formed. In addition, the part shown by 30 in drawing 2 is a heating furnace containing a heater 2.

[0015] Furthermore, the vertical mold thermal treatment equipment is equipped with the control section 5 as shown in drawing 1 . Although one block has shown this control section 5 briefly, each controller which controls the calorific value of a heater 2 (2a-2e), the flow rate of raw gas, the pressure in a coil 1, etc. according to input control units, such as a touch panel which performs a recipe, a setup of a parameter, etc. in fact, and the program specified by this input control unit is included. Moreover, a full batch mode and a short batch mode can be set up now as the mode in which a wafer is carried in a wafer boat 4 so that it may mention later. The control section 5 read the temperature set point of each zone according to these modes from memory, and is equipped with the function which controls the calorific value of the heater 2 (2a-2e) of each stage by the PID-control system based on this read value and the detection value of a temperature detecting element established within and without the coil 1.

[0016] Next, the adjustment process performed before carrying out membrane formation processing to a product wafer is explained. In an above-mentioned vertical mold thermal treatment equipment, a full batch mode and a short batch mode can be set up now like previous statement, and a full batch mode here is in the condition which carried a full load of the wafer W which contains 150 product wafers in a wafer boat 4 in this example. While laying six side wafers in the upper case side of a wafer boat 4 and specifically laying seven side wafers in a lower-berth side, respectively, 150 product wafers are carried between them and seven monitor-wafers are made further scattered in this product wafer group. On the other hand, as a short batch mode shows an example to drawing 3 , seven side wafers SW are laid in a lower-berth side. Lay 100 product wafers PW on it, and five dummy wafers DW are further laid on it. Thus, it is the

mode in which Wafer W (the sign of "W" shall be attached when indicating a wafer in the gross) is carried in a wafer boat 4 by bottom stuffing, and an upper case side serves as a free area (non-laid field) by which Wafer W is not laid in the retention groove 44 from the installation field of these wafers W.

[0017] In this example, when laying 50 product wafers PW besides in the case of laying 100 product wafers PW as a class of short batch mode, three kinds are prepared with the case where 25 product wafers PW are laid. Drawing 4 is drawing showing typically the mode of loading of the wafer W at the time of a full batch mode, and the mode of the wafer W at the time of each short batch, and in order to evaluate the condition of processing over the product wafer PW in a product wafer PW group in any case, it is making the monitor-wafer MW intervene. Moreover, although the monitor-wafer MW is made to have intervened according to batch size also in a short batch mode in a product wafer PW group, in this example, five dummy wafers DW were laid, for example, and the homogeneity of heat treatment is secured to the upper part side which is further equivalent to the downstream of the flow of the raw gas in a product wafer PW group. In addition, in drawing 4 , the whole number of stages (170 steps) and the rate of the installation field of a wafer are not arranged from a limit of the area of drawing.

[0018] And the laying temperature of each zone in a full batch mode and a short batch mode is adjusted. Although drawing 4 has indicated the product wafer PW as a mode in the case of obtaining an actual product, at this temperature-control process, the dummy wafer DW is used instead of the product wafer PW. At this process, Wafer W is carried in a wafer boat 4 corresponding to each mode. Membrane formation processing (process) is performed on the same processing conditions as the processing which carries in in a reaction container and is actually performed to a product wafer. The thickness of the thin film formed by the monitor-wafer MW is investigated, and parameters, such as the laying temperature of each zone, i.e., the laying temperature inputted into the control system of the heater 2 (2a-2e) of each stage, are adjusted based on the result. In addition, the part of processing of a product wafer indicates an example of membrane formation processing.

[0019] and at the adjustment process in a short batch mode By drawing 4 , as a dotted line shows, the monitor-wafer MW is laid also in a free area. It is based on the measurement result of the thickness of the thin film formed by the monitor-wafer MW by which it was placed between the fields (the dummy wafer DW is arranged in this case) to which the inside PW of the wafer W group which put the measurement result of the thickness of the thin film formed by this monitor-wafer MW and the bottom, and was carried out, i.e., a product wafer, is arranged. the membrane formation rate and EQC of a field to which Wafer W stuffed the bottom and the membrane formation rate of the monitor-wafer MW of a free area was carried out — or the laying temperature of the zone corresponding to a free area is adjusted so that it may become small. That is, this laying temperature becomes smaller than the laying temperature of the heater 2 concerned at the time of a full batch mode. In this case, it is required to carry out a temperature control so that the homogeneity of the thickness within a wafer side and the homogeneity within a field of the thickness between wafers may not be spoiled about the monitor-wafer MW of the field where the product wafer PW is arranged. Moreover, since it will be hard coming to evaluate the amount of the thin film which the amount in which raw gas is consumed with the monitor-wafer MW concerned increases, and adheres to the wall of the reaction container corresponding to the free area at the time of an actual process if there are too many the numbers when laying the monitor-wafer MW in a free area, one monitor-wafer MW is arranged, for example in one zone.

[0020] Thus, an example of the laying temperature of the heater 2 of each fixed stage is shown in drawing 4 . If the case of explanation where lay n product wafers PW and a short batch is performed for convenience will be indicated to be Ln here, the monitor-wafer MW of a free area is laid in the 7th step from a top by L100, and is laid in the 7th step and the 46th step by each from the top by L50 and L25. For the zone of the maximum upper case, and C-T, in drawing 4 , the 2nd step of zone and CB are [TOP / the 4th step of zone and BTM of the 3rd step of zone and C-B] the 5th step of zones from a top. Although the laying temperature of TOP is 780 degrees C in a full batch mode, it is low with 775 degrees C in L100, L50, and L25. Moreover,

although the laying temperature of C-T is 770 degrees C in a full batch mode, in L50 and L25, it is set as 768 degrees C and 766 degrees C, respectively.
[0021] In it, it is made to perform the so-called tilt temperature control which attached the inclination so that temperature might become high gradually focusing on the process temperature of 770 degrees C as it goes to the downstream from the upstream of the flow direction of raw gas (i.e., as it goes by this example upwards from under a wafer boat 43), so that the laying temperature of a full batch mode may show. The homogeneity of the thickness between Wafers W becomes high by doing in this way.
[0022] Next, signs that membrane formation processing is performed to a product wafer using an above-mentioned vertical mold thermal treatment equipment are described. The mode of batch size, for example, the full batch shown in drawing 4 , and the mode chosen from L100, L50, and L25 are first inputted into a control section 5, and a wafer is transferred from the conveyance arm which is not illustrated to a wafer boat 4 according to this mode. Although the condition of the array of a wafer is as having indicated to drawing 4 , in a short batch mode (L100, L50, L25), the monitor-wafer MW is not arranged at a free area. And a boat elevator 12 is raised, a wafer boat 4 is carried in in a reaction container, and it enlarges with the predetermined programming rate to the value which showed the laying temperature of each zone to drawing 4 . After the temperature of each zone in a reaction container is stabilized to target temperature, predetermined raw gas, for example, dichloro silane gas, and ammonia gas are supplied by the predetermined flow rate from a gas supply line 31 (31a, 31b), and nitrogen gas is further supplied by the predetermined flow rate as inert gas. These raw gas goes up from under a wafer boat 4, and it turns up by inner-tube 1a, and is exhausted from an exhaust pipe 32 through the clearance between inner-tube 1a and outer-tube 1b, and the inside of a reaction container is maintained by the predetermined degree of vacuum by carrying out evacuation with the vacuum pump which is not illustrated. At this time, a wafer boat 4 rotates to the circumference of a vertical axis, dichloro silane gas and ammonia gas react, the silicon nitride film which is that resultant accumulates on Wafer W, and membrane formation processing is performed.
[0023] According to the gestalt of the above-mentioned implementation, in performing a short batch mode, the monitor-wafer MW is beforehand arranged to a free area, and the laying temperature of a free area is adjusted so that it may become equivalent to the thickness (membrane formation rate) of the wafer W which measured the thickness of the monitor-wafer MW concerned and the thickness (membrane formation rate) put on the installation field of the product wafer PW. Although many film adheres to a reaction container and a wafer boat 4 in this example, since the reaction container in a free area and the installation field of Wafer W and the built up film thickness of a wafer boat 4 are equal to an equipment component by adjusting laying temperature in this way, only the part in which Wafer W does not exist compared with the case where it carries a full load of Wafer W in a free area can suppress that a maintenance cycle (washing cycle) becomes short.
[0024] As it is not restricted when a short batch mode packs Wafer W the bottom and arranges it as mentioned above above at a wafer boat 4, but shown in drawing 5 (a), you may be the case where upper-****** Wafer W to a wafer boat 4, and the bottom is made into a free area, or as shown in drawing 5 (b), you may be the case where bring near Wafer W by the center section of the wafer boat 4, and the top and bottom are made into a free area.
[0025] Moreover, the technique of predicting the reaction container in the location corresponding to a free area and the built up film thickness of a wafer boat 4 is also included in the right range, without this invention adjusting laying temperature like the gestalt of the above-mentioned implementation based on the measurement result of the thickness of the monitor-wafer MW arranged to the free area. Furthermore, adjustment of the laying temperature of a free area may be carried out as [become / the membrane formation rate of the monitor-wafer MW of a free area / smaller than the membrane formation rate of the wafer W put on the installation field of the product wafer PW]. Furthermore, when performing a process again not only to a temperature-control process but to the product wafer PW, the monitor-wafer MW may be arranged to a free area and you may act to it as the monitor of the thickness. In addition, this invention is applicable not only to a vertical mold thermal treatment equipment but a horizontal-

type thermal treatment equipment.

[0026]

[Effect of the Invention] Since the monitor-wafer MW is arranged to the free area and thickness is measured when the short batch which carries the substrate of number of sheets smaller than the maximum loading number of sheets of a substrate in a substrate holder performs membrane formation processing according to this invention Since the built up film thickness of the film adhering to the equipment component (a gestalt the reaction container and wafer boat 4 of operation) in the location corresponding to a free area can be predicted, therefore it can maintain to suitable timing The particle contamination by film peeling from an equipment component can be prevented. Moreover, since the laying temperature of a free area is adjusted so that the membrane formation rate of the monitor-wafer MW concerned may become smaller on a par with the membrane formation rate of the wafer W put on the installation field of the product wafer PW than it based on the measurement result of the thickness of said monitor-wafer MW, it can suppress that a maintenance cycle becomes short.

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TECHNICAL FIELD

[Industrial Application] This invention relates to the membrane formation approach and membrane formation equipment.

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PRIOR ART

[Description of the Prior Art] many — for example, the vertical mold thermal treatment equipment is known as equipment which bundles up to several semi-conductor wafers (henceforth a wafer), and performs membrane formation processing. the wafer boat 91 which is a wafer holder as this equipment is shown in drawing 6 — many — several wafers W are held to ledged, it carries in from a lower part side in the reaction container 92 of a vertical mold, and lower limit opening is plugged up, heating Wafer W to predetermined process temperature at the heater 93 formed in the perimeter of the reaction container 92, raw gas is supplied and membrane formation processing by CVD is performed to Wafer W. By the way, if it is in recently, since a variety of semiconductor devices are required, heat treatment may be needed to the wafer W of many forms with a small lot. For this reason, when [which is full number of sheets, for example as a product wafer] performing processing of 150 sheets, for example, supposing a wafer boat 91 is in the full batch condition which turns into a loaded condition, the short batch mode which heat-treats by carrying number of sheets smaller than it, for example, 100 sheets, 50 sheets, or 25 product wafers in a wafer boat 91 may be given into a recipe. The loading condition of the wafer W shown in drawing 6 corresponds to a short batch mode, makes Wafer W bottom stuffing, and makes the upper part side the free area.
[0003] When performing such a short batch mode, it is not a best policy from a cost side that only insufficient number of sheets carries a full load of a wafer boat 91 using a dummy wafer. The reason has an expensive dummy wafer and is because it is finally discarded by repeat use, so a running cost soars. Then, it is examining performing homogeneous high heat treatment by performing the various devices of using the dummy wafer of the pressure regulation corresponding to the method of installation of a product wafer, and a short batch a few, forming a free area without making a wafer boat 91 into a loaded condition.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since the monitor-wafer MW is arranged to the free area and thickness is measured when the short batch which carries the substrate of number of sheets smaller than the maximum loading number of sheets of a substrate in a substrate holder performs membrane formation processing according to this invention Since the built up film thickness of the film adhering to the equipment component (a gestalt the reaction container and wafer boat 4 of operation) in the location corresponding to a free area can be predicted, therefore it can maintain to suitable timing The particle contamination by film peeling from an equipment component can be prevented. Moreover, since the laying temperature of a free area is adjusted so that the membrane formation rate of the monitor-wafer MW concerned may become smaller on a par with the membrane formation rate of the wafer W put on the installation field of the product wafer PW than it based on the measurement result of the thickness of said monitor-wafer MW, it can suppress that a maintenance cycle becomes short.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, he is trying to decide the timing which predicts the built up film thickness of the wall of a wafer boat 91 and the reaction container 92 based on [since a possibility that film peeling will take place if a thin film adheres to the wall of the wafer boat 91 which is the equipment component exposed to a heat treatment ambient atmosphere, and the reaction container 92 and thickness becomes large, and particle may occur becomes large] the target thickness of a product wafer, and washes a wafer boat 91 and the reaction container 92 based on the prediction result. However, when carrying out membrane formation processing of the wafer in short batch, in order that there may be no wafer which consumes membrane formation gas in a free area, the membrane formation rate in the part located in the free area in a wafer boat 91 and the reaction container 92 becomes larger than the membrane formation rate of the part located in the field in which the wafer is laid. For this reason, as shown in drawing 6 in [container / 92 / reaction] image, the built up film thickness of the former thin film 90 will become larger than the built up film thickness of the latter thin film 90. It is necessary to wash the reaction container 92 before the timing of washing for which it opted beforehand as a result, and the technical problem that a maintenance cycle becomes short occurs. Moreover, since the built up film thickness of a part located in the free area in a wafer boat 91 and the reaction container 92 cannot be grasped, it is difficult to predict a maintenance cycle.

[0005] It is in offering the technique in which the purpose can predict the built up film thickness which adheres to the part located in the free area in an equipment component in performing membrane formation processing of a substrate by the short batch mode in which a free area exists, without carrying a full load in a holder of a substrate by this invention being made by the basis of such a situation, and a maintenance cycle can prevent from becoming short.

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MEANS

[Means for Solving the Problem] The full batch mode which supplies raw gas in a reaction container and performs membrane formation processing to a substrate while invention of claim 1 carries a full load of a substrate in the holder which carries out array maintenance of many substrates in the die-length direction of a reaction container, carries it in in a reaction container and heating the inside of a reaction container, In the approach of performing membrane formation processing using the membrane formation processor equipped with the short batch mode which performs membrane formation processing where it made the substrate holding to a part of installation field of the substrate in said holder and the remaining installation fields are made into a free area The process which lays a monitor substrate in said free area, and performs a short batch mode, It is characterized by including the process which predicts the built up film thickness of the equipment component in the location corresponding to a free area based on the measurement result of the thickness in the process which measures the thickness of said monitor substrate, and this process after this process.
[0007] "The process which lays a monitor substrate in a free area and performs a short batch mode" in this invention may be performed in the process which may carry out to the adjustment process before actually performing membrane formation processing to a product wafer, or performs membrane formation processing to a product wafer. Since according to this invention the built up film thickness of the film adhering to the equipment component (a gestalt the reaction container and wafer boat 4 of operation) in the location corresponding to a free area can be predicted, therefore it can maintain to suitable timing, the particle contamination by film peeling from an equipment component can be prevented.
[0008] The process which invention of claim 2 lays a monitor substrate in a free area, and performs a short batch mode, It is based on the measurement result of the thickness in the process which measures the thickness of said monitor substrate, and this process after this process. It is characterized by including the process which adjusts the temperature of the ambient atmosphere corresponding to a free area so that the membrane formation rate of said monitor substrate may become [whether it is almost the same as the membrane formation rate in the field to which the substrate is arranged, and] rather than it.
[0009] Invention of claim 3 is characterized by setting up the ambient temperature in which a free area is located lower than the ambient temperature of the location concerned at the time of a full batch mode, when performing a short batch mode.
[0010] Only the part in which a substrate does not exist compared with the case where it carries a full load of a substrate in a free area can suppress that a maintenance cycle (washing cycle) becomes short by adjusting laying temperature like these invention, although many film adheres to an equipment component.
[0011] Moreover, this invention is realized also as membrane formation equipment, and the equipment is characterized by the laying temperature of the ambient atmosphere in which the free area at the time of a short batch mode is located being lower than the laying temperature of the ambient atmosphere of the location concerned at the time of a full batch mode.
[0012]
[Embodiment of the Invention] The example which enforces the membrane formation approach of

this invention with a vertical mold thermal treatment equipment is given to below, and the gestalt of implementation of invention is explained to it. This equipment is equipped with the coil 1 of the double pipe structure of the product made from a quartz for example, which consists of outer-tube 1b which inner-tube 1a and the upper limit both ends are carrying out [upper limit] opening blockade if the configuration of a vertical mold thermal treatment equipment is explained referring to drawing 1 and drawing 2 first. If the heat treatment ambient atmosphere in this coil 1 is seen from a control system, it is divided into five steps of zones. And around the coil 1, the heater 2 which is the heating means which consists of a resistance heating element is divided into percent, for example, five steps, up and down for two or more minutes, for example, and heater 2a of each stage, 2b, and 2c, 2d and 2e are constituted, respectively so that heating control of five steps of said zones may be taken charge of.

[0013] Inner-tube 1a and outer-tube 1b are supported on the tubed manifold 3 in a lower part side. To this manifold 3 They are two or more gas supply lines 31 (two gas supply lines 31a and 31b are shown for convenience by a diagram.) so that a feed hopper may carry out opening to the lower field inside inner-tube 1a. While being prepared, the exhaust pipe 32 by which the end side was connected to the vacuum pump which is not illustrated so that it may exhaust from between inner-tube 1a and outer-tube 1b is connected. A reaction container is constituted from this example by inner-tube 1a, outer-tube 1b, and the manifold 3.

[0014] Furthermore, the lid 11 is formed so that lower limit opening of a manifold 3 may be plugged up, and this lid 11 is formed on the boat elevator 12. On a lid 11, the rotation base 14 is formed through the revolving shaft 13 which rotates by the mechanical component which is not illustrated, and the wafer boat 4 which is a substrate holder is carried through the heat insulation unit 15 which consists of a heat insulating mould on this rotation base 14. Two or more stanchions 43 are formed between a top plate 41 and a bottom plate 42, and a wafer boat 4 is constituted, as shown in drawing 2 , and it is constituted so that the wafer W which are many substrates can be laid in ledged by holding the periphery of each wafer W to the retention groove 44 formed in said stanchion 43. **** to which the product wafer W is made as for a wafer boat 4 — from the monitor-wafers which act as the monitor of the condition of processing being also scattered, and being placed, while the wafer called a side wafer to an upper limit and lower limit side is laid at the time of a full batch, in order to put on a uniform heating ambient atmosphere If it is in some which a number of slots which expected these wafers in addition to the product wafer are installed, for example, carry 150 product wafers W, the retention groove 44 for 170 sheets is formed. In addition, the part shown by 30 in drawing 2 is a heating furnace containing a heater 2.

[0015] Furthermore, the vertical mold thermal treatment equipment is equipped with the control section 5 as shown in drawing 1 . Although one block has shown this control section 5 briefly, each controller which controls the calorific value of a heater 2 (2a-2e), the flow rate of raw gas, the pressure in a coil 1, etc. according to input control units, such as a touch panel which performs a recipe, a setup of a parameter, etc. in fact, and the program specified by this input control unit is included. Moreover, a full batch mode and a short batch mode can be set up now as the mode in which a wafer is carried in a wafer boat 4 so that it may mention later. The control section 5 read the temperature set point of each zone according to these modes from memory, and is equipped with the function which controls the calorific value of the heater 2 (2a-2e) of each stage by the PID-control system based on this read value and the detection value of a temperature detecting element established within and without the coil 1.

[0016] Next, the adjustment process performed before carrying out membrane formation processing to a product wafer is explained. In an above-mentioned vertical mold thermal treatment equipment, a full batch mode and a short batch mode can be set up now like previous statement, and a full batch mode here is in the condition which carried a full load of the wafer W which contains 150 product wafers in a wafer boat 4 in this example. While laying six side wafers in the upper case side of a wafer boat 4 and specifically laying seven side wafers in a lower-berth side, respectively, 150 product wafers are carried between them and seven monitor-wafers are made further scattered in this product wafer group. On the other hand, as a short batch mode shows an example to drawing 3 , seven side wafers SW are laid in a lower-berth side. Lay

100 product wafers PW on it, and five dummy wafers DW are further laid on it. Thus, it is the mode in which Wafer W (the sign of "W" shall be attached when indicating a wafer in the gross) is carried in a wafer boat 4 by bottom stuffing, and an upper case side serves as a free area (non-laid field) by which Wafer W is not laid in the retention groove 44 from the installation field of these wafers W.

[0017] In this example, when laying 50 product wafers PW besides in the case of laying 100 product wafers PW as a class of short batch mode, three kinds are prepared with the case where 25 product wafers PW are laid. Drawing 4 is drawing showing typically the mode of loading of the wafer W at the time of a full batch mode, and the mode of the wafer W at the time of each short batch, and in order to evaluate the condition of processing over the product wafer PW in a product wafer PW group in any case, it is making the monitor-wafer MW intervene. Moreover, although the monitor-wafer MW is made to have intervened according to batch size also in a short batch mode in a product wafer PW group, in this example, five dummy wafers DW were laid, for example, and the homogeneity of heat treatment is secured to the upper part side which is further equivalent to the downstream of the flow of the raw gas in a product wafer PW group. In addition, in drawing 4 , the whole number of stages (170 steps) and the rate of the installation field of a wafer are not arranged from a limit of the area of drawing.

[0018] And the laying temperature of each zone in a full batch mode and a short batch mode is adjusted. Although drawing 4 has indicated the product wafer PW as a mode in the case of obtaining an actual product, at this temperature-control process, the dummy wafer DW is used instead of the product wafer PW. At this process, Wafer W is carried in a wafer boat 4 corresponding to each mode. Membrane formation processing (process) is performed on the same processing conditions as the processing which carries in in a reaction container and is actually performed to a product wafer. The thickness of the thin film formed by the monitor-wafer MW is investigated, and parameters, such as the laying temperature of each zone, i.e., the laying temperature inputted into the control system of the heater 2 (2a-2e) of each stage, are adjusted based on the result. In addition, the part of processing of a product wafer indicates an example of membrane formation processing.

[0019] and at the adjustment process in a short batch mode By drawing 4 , as a dotted line shows, the monitor-wafer MW is laid also in a free area. It is based on the measurement result of the thickness of the thin film formed by the monitor-wafer MW by which it was placed between the fields (the dummy wafer DW is arranged in this case) to which the inside PW of the wafer W group which put the measurement result of the thickness of the thin film formed by this monitor-wafer MW and the bottom, and was carried out, i.e., a product wafer, is arranged. the membrane formation rate and EQC of a field to which Wafer W stuffed the bottom and the membrane formation rate of the monitor-wafer MW of a free area was carried out — or the laying temperature of the zone corresponding to a free area is adjusted so that it may become small. That is, this laying temperature becomes smaller than the laying temperature of the heater 2 concerned at the time of a full batch mode. In this case, it is required to carry out a temperature control so that the homogeneity of the thickness within a wafer side and the homogeneity within a field of the thickness between wafers may not be spoiled about the monitor-wafer MW of the field where the product wafer PW is arranged. Moreover, since it will be hard coming to evaluate the amount of the thin film which the amount in which raw gas is consumed with the monitor-wafer MW concerned increases, and adheres to the wall of the reaction container corresponding to the free area at the time of an actual process if there are too many the numbers when laying the monitor-wafer MW in a free area, one monitor-wafer MW is arranged, for example in one zone.

[0020] Thus, an example of the laying temperature of the heater 2 of each fixed stage is shown in drawing 4 . If the case of explanation where lay n product wafers PW and a short batch is performed for convenience will be indicated to be Ln here, the monitor-wafer MW of a free area is laid in the 7th step from a top by L100, and is laid in the 7th step and the 46th step by each from the top by L50 and L25. For the zone of the maximum upper case, and C-T, in drawing 4 , the 2nd step of zone and CB are [TOP / the 4th step of zone and BTM of the 3rd step of zone and C-B] the 5th step of zones from a top. Although the laying temperature of TOP is 780

degrees C in a full batch mode, it is low with 775 degrees C in L100, L50, and L25. Moreover, although the laying temperature of C-T is 770 degrees C in a full batch mode, in L50 and L25, it is set as 768 degrees C and 766 degrees C, respectively.

[0021] In it, it is made to perform the so-called tilt temperature control which attached the inclination so that temperature might become high gradually focusing on the process temperature of 770 degrees C as it goes to the downstream from the upstream of the flow direction of raw gas (i.e., as it goes by this example upwards from under a wafer boat 43), so that the laying temperature of a full batch mode may show. The homogeneity of the thickness between Wafers W becomes high by doing in this way.

[0022] Next, signs that membrane formation processing is performed to a product wafer using an above-mentioned vertical mold thermal treatment equipment are described. The mode of batch size, for example, the full batch shown in drawing 4 , and the mode chosen from L100, L50, and L25 are first inputted into a control section 5, and a wafer is transferred from the conveyance arm which is not illustrated to a wafer boat 4 according to this mode. Although the condition of the array of a wafer is as having indicated to drawing 4 , in a short batch mode (L100, L50, L25), the monitor-wafer MW is not arranged at a free area. And a boat elevator 12 is raised, a wafer boat 4 is carried in in a reaction container, and it enlarges with the predetermined programming rate to the value which showed the laying temperature of each zone to drawing 4 . After the temperature of each zone in a reaction container is stabilized to target temperature, predetermined raw gas, for example, dichloro silane gas, and ammonia gas are supplied by the predetermined flow rate from a gas supply line 31 (31a, 31b), and nitrogen gas is further supplied by the predetermined flow rate as inert gas. These raw gas goes up from under a wafer boat 4, and it turns up by inner-tube 1a, and is exhausted from an exhaust pipe 32 through the clearance between inner-tube 1a and outer-tube 1b, and the inside of a reaction container is maintained by the predetermined degree of vacuum by carrying out evacuation with the vacuum pump which is not illustrated. At this time, a wafer boat 4 rotates to the circumference of a vertical axis, dichloro silane gas and ammonia gas react, the silicon nitride film which is that resultant accumulates on Wafer W, and membrane formation processing is performed.

[0023] According to the gestalt of the above-mentioned implementation, in performing a short batch mode, the monitor-wafer MW is beforehand arranged to a free area, and the laying temperature of a free area is adjusted so that it may become equivalent to the thickness (membrane formation rate) of the wafer W which measured the thickness of the monitor-wafer MW concerned and the thickness (membrane formation rate) put on the installation field of the product wafer PW. Although many film adheres to a reaction container and a wafer boat 4 in this example, since the reaction container in a free area and the installation field of Wafer W and the built up film thickness of a wafer boat 4 are equal to an equipment component by adjusting laying temperature in this way, only the part in which Wafer W does not exist compared with the case where it carries a full load of Wafer W in a free area can suppress that a maintenance cycle (washing cycle) becomes short.

[0024] As it is not restricted when a short batch mode packs Wafer W the bottom and arranges it as mentioned above above at a wafer boat 4, but shown in drawing 5 (a), you may be the case where upper-****** Wafer W to a wafer boat 4, and the bottom is made into a free area, or as shown in drawing 5 (b), you may be the case where bring near Wafer W by the center section of the wafer boat 4, and the top and bottom are made into a free area.

[0025] Moreover, the technique of predicting the reaction container in the location corresponding to a free area and the built up film thickness of a wafer boat 4 is also included in the right range, without this invention adjusting laying temperature like the gestalt of the above-mentioned implementation based on the measurement result of the thickness of the monitor-wafer MW arranged to the free area. Furthermore, adjustment of the laying temperature of a free area may be carried out as [become / the membrane formation rate of the monitor-wafer MW of a free area / smaller than the membrane formation rate of the wafer W put on the installation field of the product wafer PW]. Furthermore, when performing a process again not only to a temperature-control process but to the product wafer PW, the monitor-wafer MW may be arranged to a free area and you may act to it as the monitor of the thickness. In addition, this

invention is applicable not only to a vertical mold thermal treatment equipment but a horizontal-type thermal treatment equipment.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the vertical section side elevation showing the vertical mold thermal treatment equipment used for the gestalt of operation of this invention.
[Drawing 2] It is the general-view Fig. showing the above-mentioned vertical mold thermal treatment equipment.
[Drawing 3] It is the side elevation showing an example of the mode of installation of the wafer in a short batch mode.
[Drawing 4] It is the explanatory view matching and showing the mode of installation of the wafer in a full batch mode and a short batch mode, and the laying temperature of the zone in a reaction container.
[Drawing 5] It is the explanatory view showing other examples of the mode of installation of the wafer in a short batch mode.
[Drawing 6] It is the explanatory view showing the situation of adhesion of the thin film of the wall of the reaction container at the time of carrying out membrane formation processing by the short batch mode by the conventional technique.
[Description of Notations]
1 Coil
11 Lid
2 (2a-2e) Heater
3 Manifold
31 Gas Supply Line
32 Exhaust Pipe
4 Wafer Boat
44 Retention Groove
5 Control Section
W Wafer
PW Product wafer
MW Monitor wafer
DW Dummy wafer

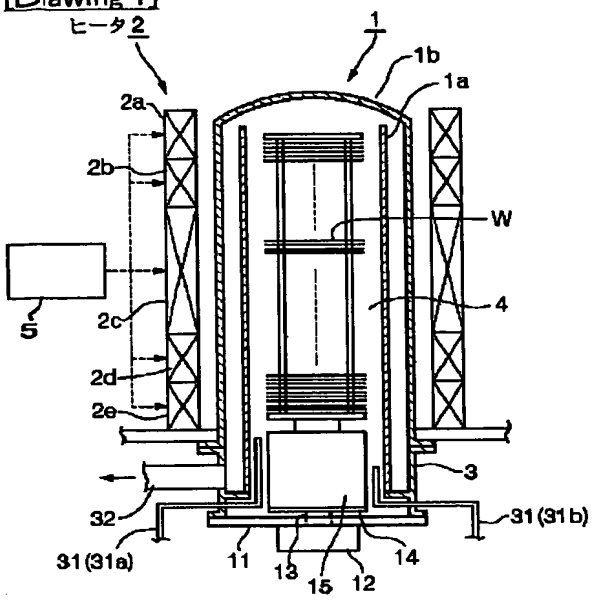
[Translation done.]

* NOTICES *

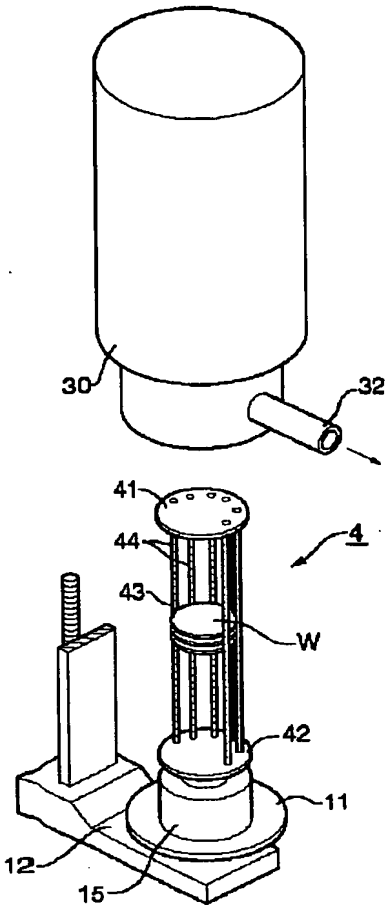
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

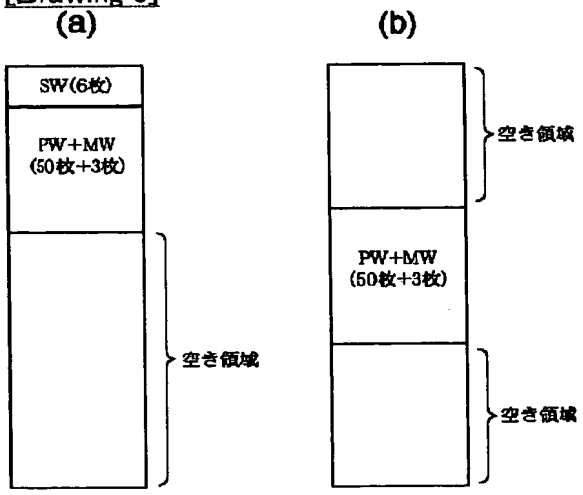
[Drawing 1]



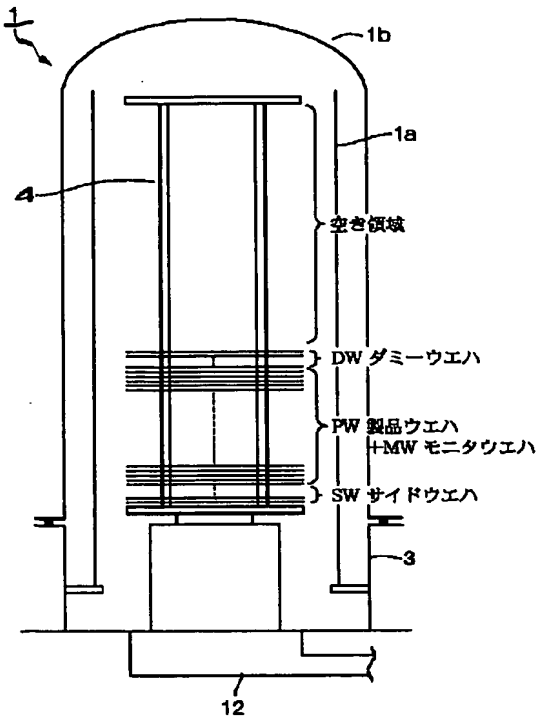
[Drawing 2]



[Drawing 5]

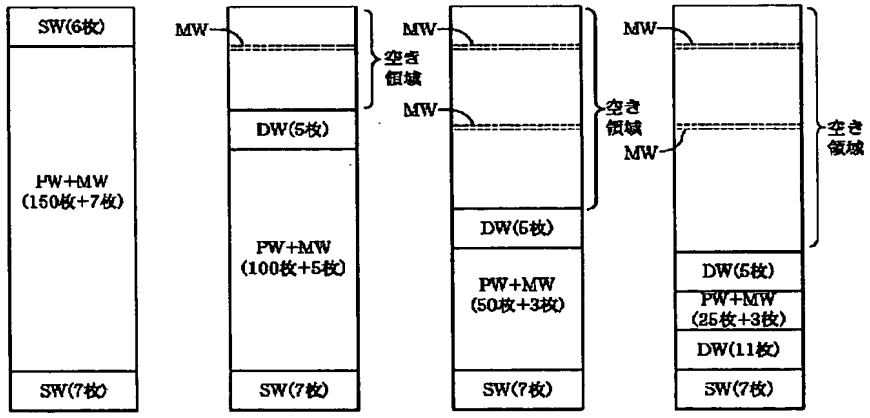


[Drawing 3]

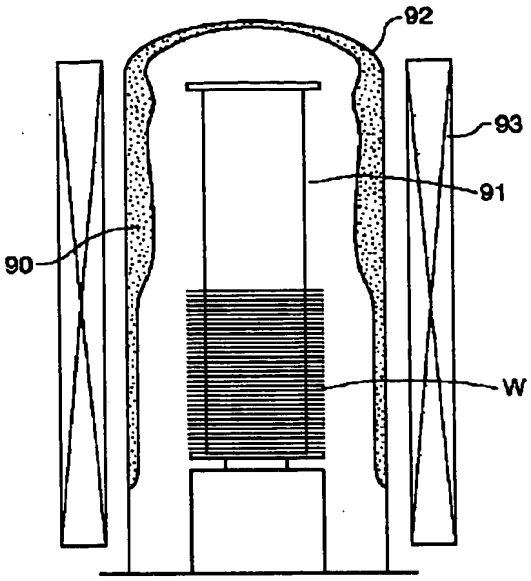


[Drawing 4]

L150(150枚:フルバッチ)		L100(100枚)	L50(50枚)	L25(25枚)
	温度(℃)	温度(℃)	温度(℃)	温度(℃)
TOP	780	775	775	775
C-T	770	768	768	766
CTR	765	765	765	765
C-B	760	760	760	760
BTM	750	750	750	750



[Drawing 6]



[Translation done.]